CLM Fall 1999 Workshop
Center for Ocean-Land-Atmosphere Studies (COLA)
Calverton, Maryland, USA

Meeting Summary

1. Introduction

The Fall 1999 Common Land Model (CLM) Workshop was hosted at the Center for Ocean-Land-Atmosphere Studies (COLA) in Calverton, Maryland, USA. The 1½ day workshop on 8-9 November 1999 focused on validation of the latest beta versions of CLM, and the plans to deliver to the community a prototype release CLM-0.0 with complete documentation in the very near future. It was the latest in a series of meetings aimed at fostering and monitoring progress, including most recently a workshop in Tucson, Arizona in March 1999, and the CSM Workshop in Breckenridge, Colorado in June 1999.

The workshop began with a welcome and introduction by J. Shukla and P. Dirmeyer, and primer by G. Bonan. There followed a number of short presentations on offline validation efforts at plot, catchment and large scale (up to global), and initial efforts at coupling CLM to CCM3. There were also presentations on complimentary and supplementary land surface modeling efforts, and opportunities to support or expand CLM development in the community. These presentations are summarized briefly later in the report. A copy of the meeting agenda, with speakers and topics, is attached.

This meeting summary is primarily meant to present the conclusions and recommendations of the discussions which came from the workshop. Most of the focus is on the practical issues of development, dissemination and support of the CLM effort at present and into the future.

2. Validation Results

Y.-J. Dai showed results of point validation of CLM in the PILPS framework. CLM appears to be performing well in these cases.

C. A. Schlosser presented more detailed results of CLM in PILPS 2(d) simulations for Valdai, Russia. The progressive improvement of CLM in the simulation of snow water equivalent and surface fluxes from CLM-β1 to CLM-β3 was shown.

K. Oleson showed the performance of CLM for the northern and southern BOREAS sites. Some problems were found in incorporating the moss layer into CLM. Otherwise, performance was nominal.

M. Bosilovich validated CLM for a location in the ARM-CART site. In particular, he performed sensitivity studies to see the impact of choice of vegetation type and vegetation cover fraction on fluxes with identical meteorological forcing.

Z.-L. Yang performed a validation over the Red-Arkansas river basin, in the mode of PILPS 2(c). Runoff was seriously underforecast when default parameters were used. A series of sensitivity tests revealed that the simulated runoff was improved after proper adjustments were made to soil water retention and infiltration properties.

I. Baker validated CLM for the Park Lake, Wisconsin site that has a very high tower with flux instrumentation, and a nearby soil and meteorology monitoring site. The CLM appeared to under-represent snow depth, but problems in the gauge-recorded snow used to force CLM may have been at fault. Soil moisture and temperature profiles were reasonable when compared to high time-resolution observational data.

P. Houser described the NCEP-NASA Land Data Assimilation System (LDAS) efforts — a near-real-time gridded $1/8^{\circ}$ offline continuous assimilation over the continental United States using multiple land surface schemes with common forcing. Plans to include CLM in the suite of models were described.

P. Dirmeyer presented results from a 2-year global gridded 1° simulation of CLM β2 in the framework of the Global Soil Wetness Project (GSWP). Runoff appears to be low globally, confirming Yang's findings.

3. Development Presentations

S. Denning described a recently funded biogeochemistry project of Ojima et al. which offers a point of collaboration for development of biogeochemistry components in the future in CLM. There are also parallels to the LDAS efforts which may be exploitable. Denning also described CLM's potential role in a recent NASA GMAP proposal.

K. Mitchell described the documentation and release of the NCEP operational land surface model (NOAH) to the community, and NCEP efforts in the LDAS project.

J. Leese described opportunities for the use of the suite of NESOB in situ data set for validation, and the potential for participation in the GEWEX Coordinated Enhanced Observing Period (CEOP).

X. Zeng gave an overview of global land surface parameter data sets which will be available for CLM, with particular emphasis on issues of heterogeneity and quantification of sub-grid scale distributions of land surface types.

Y.-J. Dai showed very preliminary results from a 15-month integration of CLM coupled to CCM3, showing that the CLM can indeed perform nominally as the land surface component in a climate model.

G. Bonan described the requirements for CLM implementation in CSM, and its potential role in the overall CSM structure. In addition, the role of CLM within the Land Working Group of CSM was described.

P. Houser described efforts to secure some support for CLM development from NASA sources, and the need to appeal to NASA missions.

P. Dirmeyer described recent GEWEX directions in land surface model development, including the ALMA initiative to develop standards and tools to simplify and facilitate land surface model development and validation across the community.

4. Open Discussion

After the first day's presentations and abbreviated discussions, the salient points were gathered and organized for more thorough discussion on the second morning. They were arranged in three categories; science issues; engineering issues; and political issues. This structure provided a launching point for resolution of outstanding problems.

Science Issues

The main science issue dealt with the performance of runoff in the CLM. It was debated whether the partial implementation of TOPMODEL concepts was to blame, and whether the solution was to include complete TOPMODEL simulation of deep soil and water table processes, or return to simple column soil physics. It was decided that since we are so late in the development cycle, the best approach would be to implement the changes that Yang had found successful for the Red Arkansas basin, and perform a quick test in the GSWP framework to check the impact globally. Other issues, such as extended snow validation, use of wider-ranging data sets, and the explicit implementation of wetlands were not to be pursued before the release of CLM-0.0, but left for future development.

CLM β4, the final beta before release of CLM-0.0, will be revalidated by all of the participating groups before the release of CLM-0.0. There should be only minor changes between CLM β4 and CLM-0.0, mostly nonfunctional concerning inline documentation. Thus, the validating groups will be well on their way to publishable results.

It was suggested that the final version of CLM must participate formally in the PILPS exercises, so that its performance can be compared to other participating land surface schemes. This is crucial for acceptance of CLM as a community model.

Engineering Issues

It was decided that the flexible F90 structure exhibited in the CLM-H version was preferable to the CCM3-specific gridding approach put into CLM for the F90-compliant β3 version. P. Houser volunteered to re-apply the CLM-H structure to the latest version, and release that as CLM-β4 (see the timetable below). Other modeling communities (biogeochemistry, hydrology, ecology) will be introduced to CLM at the earliest opportunity — certainly with the release of CLM-0.0.

Maintenance of the code was not decided. Development of CLM0 into CLM1 will be lead by a group other than the U. Arizona contingent, per the plan laid out in Tucson in March that responsibilities should rotate among participating groups. Compelling arguments were presented for having the developers of CLM-0.0 maintain all CLM-0.X code, having the developer of CLM-1 maintain and evolve CLM-0 into CLM-1 over time, and having CLM-0 evolve freely and divergently among users for a period of time, allowing leadership for CLM-1 to emerge on its own and enforce convergence at a later date.

It was decided that the code should be distributed with complete documentation, both internal and external. There should be a means of providing user support in an open framework, so that users can communicate with each other as well as with developers, taking some of the support burden off of those maintaining the code. This listserver or bulletin-board approach has proven very successful for other supporting users of other freeware.

Political Issues

It was decided that collaboration with the Ojima et al. project should be pursued. CLM code will be openly shared with the group to spark collaboration. A request by S. Running, an investigator in the project, to have an advance look at the CLM code were decided to be granted.

Funding for maintenance and development will be pursued by several avenues. Existing science proposals by Denning include plans for CLM development. Future proposals which can logically include support for CLM should be written to do so.

Support should be pursued for Bonan to help implement CLM in the CSM framework. Support for a programmer for several months should be sufficient to plug CLM into the CSM flux coupler, pre- and post-processing. A recommendation was made to place a formal request to the CSM Scientific Steering Committee describing the community development efforts to date, and requesting that funding be found to complete the task at the risk of squandering a great deal of community enthusiasm and goodwill.

Promotion of CLM through publishing and conference presentations was discussed. A publication plan is described below. Efforts will be made to organize a special CLM session at a conference during 2000 — possibly the spring or fall AGU meeting.

It was also deemed necessary to advertize the CLM to our land surface modeling colleagues in the United States and abroad in an inclusive manner, perhaps by sponsoring a broader workshop where a number of key scientists not previously involved in CLM will be invited. This will provide an opportunity to educate the community about our efforts, and expand the base of contributors to the CLM effort. CLM's strength is the diversity of its contributors, and this diversity should continue to be expanded.

5. Conclusions

Definition of the CLM

The CLM is a single column (soil-snow-vegetation) biogeophysical model of the land surface, appropriate for climate applications, whose code will be standard Fortran 90, and is referred to as the "core" code. This core can be imbedded in a driver which handles the initialization of land surface state variables, the input of required parameters and meteorological forcing variables, and the output of prognostic and diagnostic land surface state variables and fluxes.

Using F90 structure, the core can exist as a point model, yet be dimensionalized within a driver to represent a mosaic (e.g., set of co-located tiles with unique surface characteristics but common atmospheric forcing), grid (spatially distributed, as coupled to a weather or climate model), or both. It should be noted that point-simulation with CLM in this driver framework is simply a special case with a vector size of 1 in each dimension. It is expected that development of drivers for specific applications of CLM will be a user issue, although there will be provided some standards and sample generic drivers that take advantage of this flexibility as part of the software distribution.

CLM also requires a set of physical parameters which define qualities of the soil, vegetation, and physical constants. These parameters are specified from external files which permit the code to be run for various scenarios without recompilation.

CLM and CSM

The original motivation for CLM came from the desire to have a truly community-developed land surface scheme as the land component of CSM. However, the CSM structure dictates that any component model be implemented via a flux coupler, and conform to CLM standards for initialization, data exchange, restart and history file production. This will involve a development effort well above and beyond the development of the land surface model. Currently, there is not an adequate combination of resources and expertise to do this either within NCAR or in the community. It is imperative that resources be found to complete the last stage of development for application in the CSM.

Otherwise, the community aspect of CSM will be thwarted, and the validity of CSM as a community project will be harmed.

CLM-0.0 will be a purely biogeophysical model. There are efforts underway in the NCAR CSM to develop biogeochemical, hydrologic, and ecological models that would work with the land surface model of CSM (currently LSM). These efforts cannot proceed independently. Therefore, it is important that if CLM is to become the land surface model of CSM, it needs to be implemented sooner, rather than later, so as not to derail the other parallel efforts. Similarly, there should be cooperation with the other groups in helping them to adopt and adapt CLM to their projects.

Hosting and dissemination of CLM

CLM β3 will continue to be distributed via anonymous FTP from the University of Arizona (ftp://stratus.atmo.arizona.edu/outgoing/CLM/). However, pending final checks of the runoff formulation, that code will be passed on the Paul Houser at NASA/GSFC for conversion to a flexible, scalable form with a general prototype multi-dimensionable driver (a la CLM-H), which will become CLM β4. That code will be distributed for beta testing from NASA/GSFC, with a corresponding web site (http://clm.gsfc.nasa.gov/) for distribution of the final code, documentation, and links to validation work performed by other CLM participants and hosted on their respective web sites. In addition, an online forum to support the user community via bulletin-board or listserver will be established.

Timetables for development of the code and documentation are given below.

Validation

The groups will repeat or continue their validation efforts as described in the presentation with CLM β4 and CLM-0.0. This work will contribute to a descriptive scientific paper and individual journal papers (see the following subsection). In addition, an attempt will be made to secure support for a programmer for Bonan to couple CLM in the CSM framework. M. Bosilovich will begin to pursue inclusion of CLM in the NASA/NCAR GCM of the DAO. Validation of CLM in coupled integrations is crucial to its ultimate success.

Publications

The first order of business is to complete a thorough **user's guide** to the CLM, including a complete scientific description of the physics involved (largely culled from existing documentation of the three existing models LSM, BATS and IAP94 from which the CLM is derived, plus technical documentation assembled by Dai over the course of development), description of the code structure and functionality (including a call tree for subroutines), and application examples that correspond to the driver and data sets used for point validation. Also to be included are descriptions and pointers for the vector and matrix capabilities built into Houser's implementation of the driver. The user's guide will be a dynamic document available over the web in printable format (e.g., PDF). It may also be published in its initial form as a technical report so as to provide a citeable reference for the model.

A brief descriptive **news article** with pointers to online resources and a few preliminary scientific results from validation efforts should be written and submitted for fast turn-around in EOS-Transactions of the AGU, and/or the GEWEX Newsletter. The purpose is to raise awareness of the release of CLM-0.0, and encourage trial by a larger community.

A multi-authored **descriptive scientific paper** should follow, with Dai and Zeng as lead authors, to be submitted to the Bulletin of the AMS, giving a complete non-technical description of the CLM physics and structure (culled from the user's guide), with a strong emphasis on applications of the model and validation results. This should be in submittable form by the Summer 2000 CSM Meeting, so that the manuscript can be circulated among the CSM community as well.

During the months between the official CLM-0.0 release (March 2000) and the 2000 CSM Meeting, it should be resolved whether the **individual scientific validation papers** describing the efforts by CLM contributors should be submitted as a group to a journal for publication as a special issue, or if the individual groups should each pursue independent routes to publication. This decision should be made by consensus among the group by email or teleconference.

Communication

The CLM group should continue to communicate as a group by email. Individual web sites can be used to post graphical results and other larger files. The CLM distribution site at NASA/GSFC will be a central linking point for CLM0 online resources and results.

If necessary, the group can use teleconferencing if the need for more interactive communication arises. S. Denning suggested a method where graphical materials can be distributed electronically in advance, and a teleconference can be used to conduct a type of distributed workshop. This methodology may be used to reduce travel requirements in the future.

Timetable for development and release of CLM-0 **code**

12 Nov 1999	Liang	Deliver runoff fixes to COLA for 2-D GSWP testing, to Dai And Zeng for implementation into CLM β3
19 Nov 1999	COLA	Check impact on global runoff
25 Nov 1999	Dai, Zeng	Deliver finalized CLM β3 code to Houser for F90 structuring.
15 Dec 1999	Houser	Circulate prototype CLM β4 for review by CLM group
31 Dec 1999	CLM group	Recommendations back to Houser on his changes
15 Jan 2000	Houser	Deliver CLM β4 as stable prototype for final testing
Jan-Feb 2000	CLM group	Repeat testing - report bugs, deliver final testing report
March 2000	CLM group	Release of CLM-0.0 to the community

Timetable for development and release of CLM-0 **documentation**

25 Nov 1999	Dai, Zeng	Deliver outline of CLM documentation to CLM group, with suggested contributors for each section (including assigned subroutines).
3 Dec 1999	Group	Confirm your assignments, begin external documentation editing
15 Dec 1999	Group	Begin internal documentation editing (mark your changes with initials, e.g.: !PAD
15 Jan 2000	Group	Return edit of internal documentation (inline in code - check for identically compiled executable) to Houser; Return edit of external documentation to Zeng.
Jan-Feb 2000	Dai, Zeng	Finalize external documentation into a technical description and user's guide for CLM-0.0
March 2000	CLM group	Release of CLM-0.0 documentation to the community

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Monday, 8 November 1999

8:30	Continental Breakfast		
9:00	Welcome and agenda	Shukla Dirmeyer	COLA
9:10	CLM Primer	Bonan	NCAR
Validation			
9:25	Point validation	Dai	U.Arizona
9:40	PILPS 2(d)	Schlosser	COLA
9:55	BOREAS	Oleson	NCAR
10:10	ARM-CART	Bosilovich	NASA/GSFC
10:25	Break		
11:00	Red-Arkansas	Yang	U. Arizona
11:15	Park Falls	Baker	CSU
11:30	2-D Simulations	Houser	NASA/GSFC
11:45	GSWP	Dirmeyer	COLA
12:00	External code evaluation	Denning	CSU
12:15	Lunch (Maurya)		
Development			
1:35	NOAH Status	Mitchell	NCEP
1:55	Land data sets Beta 3 to CLM v1.0	Zeng	U. Arizona
2:15	NESOB and CEOP data sets	Leese	NOAA/OGP
2:30	CCM3 coupling	Dai	U. Arizona
2:50	CSM activities/needs/requirements	Bonan	NCAR
3:10	NASA GMAP Proposal Ojima Project	Denning	CSU
3:30	Break		
3:50	CLM-2 NASA Initiative	Houser	NASA/GSFC
4:20	CLM and ALMA	Dirmeyer	COLA
4:45	Open discussion	*All*	
5:30	Adjourn for day		
Evening	Dinner (94th Aero Squadron)		

Tuesday, 9 November 1999

8:30	Continental Breakfast	
9:00	Discussion	
12:00	Adjourn	

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8-9 November 1999
COLA, Calverton, Maryland, USA

Attendees:

Ian	Baker	CSU	baker@dendrus.atmos.colostate.edu
Gordon	Bonan	NCAR	bonan@bearmtn-e0.cgd.ucar.edu
Michael	Bosilovich	NASA/GSFC	mikeb@dao.gsfc.nasa.gov
Yong-jiu	Dai	U. Arizona	dai@stratus.atmo.arizona.edu
Scott	Denning	CSU	denning@atmos.colostate.edu
Robert	Dickinson	Georgia Tech	robted@eas.gatech.edu
Paul	Dirmeyer	COLA	dirmeyer@cola.iges.org
Michael	Ek	NCEP	michael.ek@noaa.gov
Mike	Fennessy	COLA	fen@cola.iges.org
Paul	Houser	NASA/GSFC, NASA/HQ	houser@dao.gsfc.nasa.gov
Menglin	Jin	U. Maryland	mejin@glue.umd.edu
John	Leese	GCIP	leese@ogp.noaa.gov
Vasu	Misra	COLA	misra@cola.iges.org
Ken	Mitchell	NCEP	kmitchell@ncep.noaa.gov
Keith	Oleson	NCAR	oleson@cgd.ucar.edu
Jon	Radakovich	NASA/GSFC	jrad@dao.gsfc.nasa.gov
Oreste	Reale	COLA	reale@cola.iges.org
Adam	Schlosser	COLA	adam@cola.iges.org
J.	Shukla	COLA	shukla@cola.iges.org
Pam	Stephens	NSF	pstephen@nsf.gov
Liqin	Tan	COLA	ltan@cola.iges.org
Zong-Liang	Yang	U. Arizona	liang@hwr.arizona.edu
Xubin	Zeng	U. Arizona	xubin@gogo.atmo.arizona.edu
Ning	Zeng	NASA/GSFC	zeng@climate.gsfc.nasa.gov